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Corn and Soil Test Response to Lime and Cattle Hoop Building Manure in 2006

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Abstract

In 1995, a liming study was initiated at the Armstrong Farm where acid soil had developed from extensive nitrogen (N) fertilizer use in continuous corn (CC) production without liming. In 2003, the experimental area was divided into thirds. A corn-soybean (CSb) rotation occupied two-thirds of the area and CC occupied the remaining third.Because cattle feeding is a major industry in the area, cattle hoop building manure was incorporated into the experiment in 2006 to evaluate soil acidity effects on its utilization by a corn crop and also on soil test values.

Keywords

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Disciplines

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Corn and Soil Test Response to Lime and Cattle Hoop Building Manure in 2006

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Introduction

In 1995, a liming study was initiated at the Armstrong Farm where acid soil had developed from extensive nitrogen (N) fertilizer use in continuous corn (CC) production without liming. In 2003, the experimental area was divided into thirds. A corn-soybean (CSb) rotation occupied two-thirds of the area and CC occupied the remaining third. Because cattle feeding is a major industry in the area, cattle hoop building manure was incorporated into the experiment in 2006 to evaluate soil acidity effects on its utilization by a corn crop and also on soil test values.

Material and Methods

Soil testing conducted in 1994 indicated that the amount of lime required to raise soil pH to 6.5 in this area was 15,000 lb/acre of effective calcium carbonate equivalent (ECCE). In April 1995, ag-lime application rates of 0, 1.67, 5, 15, and 45 ton/acre were applied to maintain an un-limed control and to achieve target pHs of 5.5, 6.0, 6.5, and 7.0. Cattle hoop building manure was applied in early April 2006 at a rate of nearly ten tons/acre. Manure samples were collected, taken to Ames and analyzed for moisture content in the lab and phosphorus (P), potassium (K) and nitrogen (N) content at the ISU Soil Testing and Plant Analysis Laboratory. The manure had a moisture content of 74% and its nutrient contents reported on a dry basis were 2.94%, 0.59%, and 1.81% N, P, and K, respectively. This added 430, 86 and 265 lb/acre of N, P, and K. After the manure was applied, the plots were disked, planted, and sprayed with herbicides by the farm staff. Corn was harvested from four rows in each plot. After harvest, six corn plants were randomly selected from adjacent, un-harvested rows where the ears and an 8-in. cornstalk segment, starting at 6 in. above the soil, were collected. The ears were shelled and the grain analyzed at the ISU Grain Quality Laboratory. Cornstalk inorganic nitrate-N (NO_3-N) and inorganic P (PO_4-P) contents were determined from extraction with Bray2 solution.

Results and Discussion

Soil test data are presented in Tables 1 and 2. Soil pH determined with water and 0.01 M calcium chloride show that lime neutralized soil acidity as desired. The lower lime rates indicated significant lime requirements as measured with the SMP buffer solution. Plant available P increased with increasing soil pH with both the Bray1 and Olsen extractants although the correlation was greater with the latter. Increasing soil pH also increased calcium (Ca) but decreased K.

Table 3 shows corn response to liming when manure is used as the added nutrient source. Corn grown in rotation with soybeans responded more markedly than CC. Increasing soil pH decreased moisture content and increased yield. Inorganic P (PO_4-P) content of corn stalks also increased with increasing pH. Nitrate-N (NO_3-N) contents were not consistently related to soil pH.

Acknowledgments

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Table 1. Soil test response to lime and manure treatments measured in 2006.

Lime rate	pH_{water}[1]	pH_{CaCl2}[1]	pH_{SMP}[1]	Bray1-P	Olsen-P	K[2]	Zn[3]
ton/acre				--------------- mg Kg^{-1}			-----------------
0	5.3	4.9	6.1	34	24	430	1.5
1.7	5.7	5.1	6.4	40	25	410	1.7
5	6.4	5.9	6.6	32	19	393	1.4
15	7.1	6.7	.	46	36	335	1.5
45	7.4	7.0	.	47	36	306	1.4

[1]pH measured 1:1 with water, 0.01 molar calcium chloride, or 1:3 SMP buffer solution.
[2]Potassium (K) determined using 1 normal ammonium acetate.
[3]Zinc (Zn) determined using DTPA solution.

Table 2. 2006 measured soil cation responses to lime and manure treatments.

Lime rate	K[1]	Ca[1]	Mg[1]	Na[1]	H[2]	CEC[3]
ton/acre			meq $100g^{-1}$			
0	1.1	10.4	2.5	0.8	8.7	23.5
1.7	1.0	11.1	2.6	0.7	6.6	22.1
5	1.0	13.8	2.6	0.7	4.4	21.4
15	0.9	16.1	2.4	0.7	.	20.1
45	0.8	17.3	2.3	0.8	.	21.1

[1]K, calcium (Ca), magnesium (Mg), sodium (Na) determined using 1 normal ammonium acetate.
[2]Hydrogen (H) determine using $[H]=(12 * 7.5\text{-}pH_{SMP}))$
[3]Cation exchange capacity (CEC) is the summation of soil cations.

Table 3. Corn responses to lime and manure in 2006.

Lime rate	Moisture	Yield	Protein	Oil	Starch	PO_4-P	NO_3-N
ton/acre	%	bu/ac		%		mg Kg^{-1}	
Corn/soybean rotation							
0	17.7	193.6	7.7	3.4	60.7	253	862
1.7	17.6	197.7	7.7	3.3	60.9	253	823
5	17.5	201.5	7.6	3.4	61.1	248	654
15	17.0	203.3	7.8	3.3	61.0	289	1,223
45	17.2	205.8	7.9	3.4	60.9	303	1,107
Continuous corn							
0	17.1	202.6	7.9	3.4	60.8	208	3,259
1.7	17.0	197.5	8.1	3.4	60.6	303	1,923
5	17.3	197.4	7.7	3.3	61.1	319	1,225
15	16.8	199.2	8.0	3.4	60.7	322	1,522
45	16.9	211.8	7.9	3.3	61.1	337	1,785